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Impact of COVID-19 on the body mass index of school students in Al-Ahsa, Saudi Arabia

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ABSTRACT

The precautionary restrictions that were imposed on school students in Saudi Arabia have significantly influenced school students' lifestyles and nutrition intake. This paper aims to reveal the effect of the Coronavirus pandemic on school students' body mass index (BMI) in the Al-Ahsa region, which is located in the eastern province of Saudi Arabia. The study used cross-sectional data that was collected randomly from school students representing all school levels in Al-Ahsa. The paper used a seemingly unrelated regression method, paired t-test, and McNaimar test to examine the factors affecting students' BMI scores before and after the Coronavirus pandemic. The most critical factor that affected the BMI of the school student indirectly is distance learning, where students spent a lot of time in front of electronic devices to study, learn, use social media, and play electronic games. These led to a decrease in their physical activity and an increase in food consumption. All these factors led to a significant increase in BMI for male and female school students. Also, the results show that fruit consumption is associated with a lower BMI score, whereas vegetable consumption is associated with a higher BMI score. The study also revealed that students infected with the Coronavirus have lower BMI scores, on average than students who were not infected with the Coronavirus. The largest impact on school students' BMI is associated with social media usage and Coronavirus infection. To the authors' knowledge, this paper is the first paper to use a seemingly unrelated regression method to reveal the impact of socio-economic and nutritional variables on students' BMI.

1. Introduction

At the end of 2019, the Chinese government reported a strange and unknown disease that causes an acute respiratory syndrome of unknown cause, and at the beginning of 2020, the type of virus circulating in the Chinese city of Wuhan that causes severe acute respiratory syndrome was detected, which is Coronavirus (COVID-19) (Zhou et al., 2020). Then the world witnessed a case of fear and panic over this strange virus, as the information about how it spread and transmitted to humans was not clear at first. The closure procedures began to spread in many countries. The first case of COVID-19 infection appeared in Saudi Arabia on March 2, 2020. The Kingdom of Saudi Arabia imposed a partial quarantine (March 23-June 21, 2020) on regions and total quarantine on other areas. It was decided due to an increase in infection and its keenness on the health of citizens and residents (MOH, 2020).

The Saudi government took all precautionary measures in all sectors, including the education sector. The second semester of the academic year 1441 AH was completed through distance learning using an e-learning platform. By the beginning of the first academic year of 1442 AH (2020-2021 AD), distance learning was implemented in all private and public education sectors in Saudi Arabia. The learning period was divided into two periods. The secondary and intermediate stages attended classes in the morning, and the primary stage attended classes in the evening period to facilitate

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collaboration among students, parents, and instructors. The application of distance learning received many positive results at first, one of the most important of which helped limit the spread of the Coronavirus. It also saved a lot of time, effort, cost, and absorptive capacity for classrooms. Engaging technology in education has increased for students, their parents, and faculty members in all disciplines. One of the disadvantages of distance learning, which may be a long-term issue for adults, children, and adolescents, is the lack of movement and physical activities as in the past. Also, the amount of food consumed and the number of main and light meals consumed during the day has increased. Frequent sitting on smartphones and electronic devices, browsing social media platforms for long times, attending online lessons, and long sleeping periods harm the health and safety of individuals (Androutsos et al., 2021).

In many countries, including Saudi Arabia, the number of children and adolescents who are overweight or obese is increasing. The increase in weight is not limited to middle and high-income countries; it is also prevalent in low-income countries, where children and adolescents suffer from malnutrition. It makes this age group vulnerable to many chronic diseases and other diseases. It raises the alarm for the health future of this generation as the number of children and adolescents with overweight and obesity reached 340 million people in 2016 (WHO, 2021). These statistics are for the period before the advent of the Coronavirus pandemic. Before the quarantine period, students stayed at home with a decrease in the rates of physical activities and increased food intake. Thus, a rise in the rates of overweight and obesity is expected after 2021 (WHO, 2021).

In general, the quarantine period during the Coronavirus pandemic affected many areas of life, such as health, economy, education, and other essential areas of our life. It affected students' health, nutritional level, and physical activity, which led to changes in their eating behaviors and healthy lifestyles. There is limited information regarding the impact of the pandemic on children and adolescents, so it is necessary to study the changes that occurred in school students during the quarantine period (Mulugeta and Hoque, 2021).

Many children and adolescents face many negative influences that affect their health. One of the most prominent influences that affected many people, especially students, is the Corona pandemic. This epidemic has caused negative changes in the health status, physical activities, nutritional habits, and behaviors of all members of society, especially the target group. This crisis changed many procedures, methods, and regulations in many sectors such as health, economy, and education. The change in the educational sector from traditional (in-person) learning to distance learning led students to stay at home and sit for long periods in front of electronic devices to attend classes, reducing their physical activity. They also increased their consumption of food, which was the reason for their high body mass index.

The purpose of the research is to study the indirect impact of distance learning during the Coronavirus pandemic on the body mass index (BMI) of school students in Al-Ahsa, Saudi Arabia. Also, the study aims to reveal the most influential aspects of students' nutrition and health during the pandemic.

2. Literature review

Mulugeta and Hoque (2021) aimed to assess the effect of quarantine during the COVID-19 pandemic on the US children's body mass index and identify the factors associated with it. The sample included 701 children. Their anthropometric measurements were analyzed in the pre and post-quarantine period. A chi-square test for categorical variables and T-test for numerical categories were also conducted. Multivariate analyses were performed to determine the factors associated with BMI. The study showed an increase in the average body mass index (BMI) from 21.07 to 21.57 in the post-quarantine period. Also, an increase in the overall obesity burden was observed, as the percentage of obesity increased from 23.2% to 27.4% in the post-quarantine period. The rate of increase in weight also raised from 41.1% to 44.5%. The percentage of obesity increased from 40.5% to 46.9%, and children (from two to five years) recorded the highest increase in the rate of obesity, where the percentage increased from 19.7% to 24.8%. The researchers concluded through this study that there is a significant increase in BMI among children in the United States during the quarantine period, which negatively affected this group. The researchers also recommended an urgent need to develop effective strategies and measures to counter the effects of quarantine during the COVID-19 pandemic to avoid the increase in weight, obesity, and their severe and unhealthy impact on children aged 18 years or less.

Androutsos et al. (2021) aimed to study the changes that occurred because of staying at home during the quarantine period in the children and adolescents' dietary habits and lifestyles. In addition, the study aims to explore the possible effect of behavioral change, healthy lifestyles, and nutritional habits. The study sample consisted of 397 children and their parents from 63 municipalities in Greece from April to May 2020. Data and information were collected through an electronic questionnaire for the target sample. The study showed that during the quarantine period, children's sleep duration increased. The study also noted that children spent more time in front of TV screens and smart devices than before, with a marked decrease in their physical activity. An increase in fruits, vegetables, juices, dairy products, starches, and sugar consumption was also observed, with an increase in the number of snacks consumed during the day for the sample members, while the consumption of fast food among children decreased. The study revealed an increase in body weight in 35% of children. The increase in

body weight is attributed to decreased physical activity and the increase in breakfast and unlimited snacks. Researchers recommended effective strategies to prevent excessive body weight gain during future COVID-19 quarantines.

Alfawaz et al. (2021) explored the effects of home quarantine during the Coronavirus pandemic on lifestyle and healthy behavior in Saudi Arabia. Researchers conducted a survey via the Google platform in Arabic and English in Saudi Arabia from May 11, 2020, to June 6, 2020. The questions provided in the questionnaire were related to the answers 'before' and 'during' the home quarantine of COVID-19. Where 1,965 people participated in the survey, where the percentage of male participants was 47%, and female participants was 53%. This study shows a significant decrease in the percentage of individuals who walk more than four times a week during the pandemic was observed. The percentage of people who practice walking before the pandemic was 30.5%, decreasing to 29.1%. The percentage increased in individuals who did not exercise daily during the quarantine (21% compared to 22.9%). The consumption of snacks during the quarantine has increased; the percentage of snack consumption during the pre-quarantine period was 27.4%, which increased to 29.4%. During the quarantine, the number of individuals who did not consume fresh fruits and vegetables on a daily basis during home quarantine also increased. The percentage of individuals who did not consume fresh fruits and vegetables in the pre-quarantine period was 2.4%, and it grew to 3.7% during the quarantine. Researchers recommended interventions that mitigate negative lifestyle behaviors during the COVID-19 pandemic.

Zemrani et al. (2021) examined the expected impact of the COVID-19 epidemic on children's nutrition and lifestyle. A children's behavior survey was conducted to determine changes in their eating habits and healthy lifestyles. The researchers concluded significant disruptions in children's eating habits, behaviors, and healthy lifestyles. The Researchers expected in this study that obesity rates will increase in middle and high-income countries, at the same time, and undernutrition will exacerbate in developing countries. The researchers expect that the impact of the Coronavirus is not limited to a viral infection, but extends beyond that to the healthy lives of children. This study shows that this crisis has an adverse effect on public health and can have lifelong consequences for children in particular. Hence, the researchers advised that effective and targeted measures must be taken mainly for children and vulnerable families to ensure children's fundamental rights to nutrition and optimum health.

Al-Domi et al. (2021) investigated the impact of quarantine during the COVID-19 pandemic on dietary behavior and healthy living practices. The data was collected using an electronic questionnaire in the period between March and April 2020. The cross-sectional study was conducted on the Jordanian population. The questionnaire included demographic and anthropometric questions and questions related to dietary behavior, such as the number of main and light meals consumed during the day, the amount of water, and habits related to physical activity. The study indicated that the number of individuals with average weight is 1561, the number of obese individuals reached 1135, while the number of underweight reached 116 individuals. During the COVID-19 quarantine period, changes in BMI were recorded (12.9% underweight, 28.5% average body weight, 36.4% overweight, and 41.1% obese). The smoking rate of individuals also increased. This study showed that there is no significant difference concerning physical activity among various health conditions of BMI. The researchers concluded that there are substantial negative changes in healthy eating behavior among Jordanians through this study. Many of them faced a significant increase in body weight and an increase in appetite and smoking during the quarantine period of the COVID-19 pandemic.

Chaturvedi et al. (2021) aimed to reveal the effect of the COVID-19 pandemic on students' academic performance, social life, and psychological and mental health. The study sample included 1182 students of different age groups from various educational institutes in Delhi, India. The study showed that the pandemic affected students' BMI, social life, psychological and mental health. The researchers also concluded that many students used different mechanisms to cope with stress and anxiety resulting from this pandemic. The researchers in this study recommended that the responsible authorities take all necessary measures to mitigate the coronavirus outbreak's negative impact and promote the pandemic's positive effects, such as the distance learning experience.

Chambonniere et al. (2021) examined the effects of home quarantine during the COVID-19 pandemic on physical activity and its determinants on French children. The sample consisted of 6491 children and chose children in the group aged 6 to 10 years, and the age group of adolescents was from 11 to 17 years. The questionnaire was published online using social media platforms from April 1, 2020, to May 6, 2020. The questionnaire included demographic data and questions related to physical activity. In this study, the researchers compared the level of physical activity, the time spent watching television, and the use of smart devices for the pre-quarantine period with the quarantine period during the COVID-19 pandemic. The results showed a decrease in the level of physical activity during the quarantine period compared to the period before the COVID-19 pandemic. The study also stated a correlation between living in a civilized area and a decrease in the level of physical activity due to the increase in the time sitting at home, the time spent watching television, and the use of smart devices among children during the quarantine period.

Gallo et al. (2020) aimed to study the effect of the quarantine policy during the COVID-19 pandemic on Australian university students' energy intake and

physical activity levels. The researchers also examined the effect of quarantine on students' diets. The paper used a 24-hour food recall form and physical activity patterns of third-year biomedical students in Australia during the early phase of the COVID-19 quarantine from March to April 2020. The study compared the results for students during the pre-pandemic period with the quarantine period. The researchers concluded that energy intake increased by 20% during the pandemic, and the rate of eating high-calorie snacks increased compared to the years 2018 and 2019. The researchers also concluded that there is a decrease in sports activities compared to the pre-pandemic period.

Zhu et al. (2021) studied the effect of home quarantine on weight gain during the COVID-19 pandemic. The sample size in this study was 889 respondents between the ages of 16 to 70 years, 61% of participants were female, and 39% were male. The researchers used an electronic questionnaire. The questionnaire was distributed to residents of Jiangsu and other provinces in China from March 29 to April 5, 2020. The questionnaire included demographic and anthropometric data and questions related to the pandemic's dietary changes, physical activity, and sleep time duration. Through the results of this study, it turns out that there is a significant increase in the total food intake by 9.8%, and there is a considerable decrease in the practice of physical activities by 31.5%. The average weight gain of the sample was 30.6%, with an average weight gain of 0.5±2.8 kg. The increase in weight was due to the rise in food intake and the decrease in physical activities. The researchers concluded that people of average weight are more likely to be overweight than those who are overweight or obese during the COVID-19 quarantine.

Jalal et al. (2021) aimed to determine the changes in body mass index, physical activity, nutritional behavior, sleep, and mental health for the period before and during quarantine. The research sample included 628 undergraduate students from King Faisal University in Al-Ahsa, where basic information for students and anthropometric measurements were collected. A questionnaire was made to measure the global physical activity questionnaire (GPAQ), dietary recall, Pittsburgh sleep quality index (PSQI), and perceived stress scale (PSP). The obtained data were analyzed by (SPSS) program. The authors concluded from this study that 32% of students gained weight, 22% lost weight, and 46% maintained the same weight during the quarantine period of the COVID-19 pandemic. The physical activity decreased and periods of sitting increased, as well as the level of stress, decreased and the level of sleep increased during the lockdown. As for dietary behaviors, calorie intake increased while the consumption of fast and fried foods decreased. Also, among the variables associated with weight changes are the level of students and the time they spend on social media on a daily basis. Finally, the researchers recommend the importance of creating a healthy awareness among students about maintaining an ideal weight and the importance of practicing physical activities and modifying unhealthy eating behaviors, especially during quarantine periods.

Childhood and adolescence periods are some of the most critical periods of human life. These periods require unique nutritional recommendations in all nutrients to meet the needs and requirements necessary for growth in these sensitive stages. It is essential to focus on everything related to these two stages, especially the health status, where the nutritional status comes first to maintain individuals' health. Hence, it was necessary to pay attention to the nutrition of children and adolescents, especially in this challenging period, where children and adolescents are exposed to many external influences that affect their eating habits. Eating fast food in large amounts, high calories and nutrients with poor nutritional value as basic meals, lack of physical activity, and staying up late at night are factors that negatively affect the health of children and adolescents. The impact is very harmful when the Coronavirus pandemic negatively affected many people staying at home for long periods, lack of movement, and eating many foods to enjoy and reduce the severity of staying at home. Therefore, in this study, we shed light on the male and female students of the school stages from these age groups (children and adolescents) because these groups are of great importance in society. The period of home quarantine and distance learning significantly impacted their healthy lives, eating habits, and behaviors.

3. Data and methodology

The analytical method was used to achieve the study's objectives in evaluating the impact of distance learning on school students during the Coronavirus pandemic. The sample size was determined using Eq. 1 (Kothari, 2004):

$$n = \frac{Z^2.p.q.N}{e^2(N-1)+Z^2.p.q} \quad (1)$$

where, n is the required sample size, N is the size of the population to be studied (N=192,773), which represents the number of male and female students from public and private schools, p is a probability value (p=q=0.5), e is the margin of error (e=10%), and Z is a standardized value (z=1.96).

The required minimum sample, according to Eq. 1, is 96 respondents. The survey was distributed to the target population via various social media apps. Also, parents of primary school students were allowed to fill out the survey on behalf of their children. The survey has been approved by the Research Ethics Committee at King Faisal University, and it has been given approval # KFU-REC/2021-06-31. The data were collected in 2021. After removing unreliable, missing, or incomplete responses, the total collected sample size reached 104 participants from the three school levels (primary, intermediate, and secondary). The characteristics of collected data

are reported in Table 1, including demographic data and anthropometric measurements. Also, the percentage of housing type, education level for students and their parents, height, weight, BMI, age, and gender for the pre/post-Coronavirus periods are revealed in Tables 2-10.

Table 1: Characteristics of the collected sample

Variable	n(Percentage)			
Female	41(39.42)			
Male	63(60.57)			
	Mean	SD	Max	Min
Age	12.13	3.189	18	6
Hight,m,(%)	1.39	0.259	1.89	0.75
Weight.before, kg	42.86	18.910	107	17
weight.after, kg	46.71	20.779	105	18
Status before				
Severe Thinness	5(4.80)			
Underweight	7(6.73)			
Normal	41(39.42)			
Overweight	14(13.46)			
Obesity	37(35.57)			
Status after				
Severe Thinness	1(0.96)			
Underweight	6(5.76)			
Normal	41(39.42)			
Overweight	14(13.46)			
Obesity	42(40.38)			
Education level				
Elementary	54(51.92)			
Intermediate	31(29.80)			
Secondary	19(18.26)			
Accommodation type				
Apartment	41(39.42)			
House-Villa	63(60.57)			
Mother education				
illiterate	1(0.96)			
Elementary-Intermediate-Secondary	44(42.3)			
Diploma	9(8.65)			
Bachelor	47(45.19)			
Postgraduate	3(2.88)			
Father education				
illiterate	2(1.92)			
Elementary-Intermediate-Secondary	38(36.53)			
Diploma	18(17.3)			
Bachelor	37(35.57)			
Postgraduate	9(8.65)			

The amount of physical activity for male and female students was calculated before and after the Coronavirus pandemic, besides studying the changes that occurred in the level of physical activity during the pandemic. The data showed a decrease in the rate of physical activity in the post-pandemic period compared to the pre-pandemic period. The percentage of students who do not engage in physical activities in the pre-pandemic period reached 46% of the study sample. In comparison, the percentage increased to 60% in some periods after the pandemic.

Table 2: Physical activity during a week

	0	1-2 times	3-5 times	everyday
Before	46(44.23)	38(36.53)	12(11.53)	8(7.69)
After	60(57.69)	31(29.8)	8(7.69)	5(4.8)

Table 3: Physical education classes (minutes)

	0	45m	+45m
Before	33(31.73)	43(41.34)	28(26.92)
After	56(53.84)	35(33.65)	13(12.50)

Table 4: Hours to watch TV and play video games

	<1h	1h	2-3h	+3h
Before	18(17.3)	19(18.26)	39(37.50)	28(26.92)
After	9(8.65)	6(5.76)	31(29.80)	58(55.76)

Table 5: Hours using social media

	<1h	1h	2-3h	+3h
Before	34(32.69)	13(12.5)	25(24.03)	32(30.76)
After	16(15.38)	17(16.34)	24(23.07)	47(45.19)

Table 6: Hours for studying using my school platforms (Madrrasti* and Microsoft Teams)

	<1h	1h	2-3h	+3h
After	36(34.61)	27(25.96)	28(26.92)	13(12.5)

*: An application used by school students and administrators

Table 7: Hours to attend online classes

	3-5h	6-8h	+8h
After	65(62.5)	36(34.61)	3(2.88)

Table 8: Number of meals in students' diet

	One meal	2 meals	3 meals	+3 meals
Before	1(0.96)	33(31.73)	61(58.65)	9(8.65)
After	-	27(25.96)	48(46.15)	29(27.88)

Table 9: Eating Fruits in students' diet

	Yes	No
Before	88(84.61)	16(15.38)
After	83(79.8)	21(20.19)

Table 10: Eating vegetables in students' diet

	Yes	No
Before	75(72.11)	29(27.88)
After	79(75.96)	25(24.03)

The data also revealed that students spend a long period of time during the day in front of the television and electronic games. The maximum period spent by students watching TV and playing on electronic devices was only 2-3 hours per day, and it represented 39% of the sampled respondents for the period before COVID-19. In addition, this percentage rose to more than 3 hours per day, which equals 58% of the sampled participants during the pandemic period. These changes are also observed in

social media usage, where there are apparent differences in the rate in the pre and post-pandemic period. Only 32% of students spent more than 3 hours a day on social media, while it rose to 47% during the pandemic. Students use of technology was not limited to entertainment; Students spent a lot of time in front of electronic devices to attend lessons and study. The data shows that 65% of students spent at least 3-5 hours per day attending online classes.

The data shows the number of meals eaten by the sampled students between the pre-pandemic period and during the pandemic. The number of people eating more than three meals during the day in the pre-pandemic period was only 9%. In contrast, this percentage reached 29% during the pandemic. Another aspect of the research was the students' intake of fruits and vegetables. The data shows a slight decrease (about 5%) in the proportion of fruit intake. In comparison, there is a slight increase (about 3%) in the consumption of vegetables during the pandemic period compared to the period before the pandemic. In order to examine the collected data empirically, several statistical tests will be conducted to find if there is a significant difference in the average BMI of students for the period before and during the pandemic. Also, the Shapiro-Wilk test will be used to examine the distribution of the collected data to select the appropriate statistical test. Furthermore, the McNaimar test will also be conducted to examine the associations between pairs of categorical variables pre-COVID-19 and during COVID-19.

Lastly, the paper will use seemingly unrelated regression methods to estimate the factors influencing students' BMI before the COVID-19 pandemic and during the COVID-19 pandemic. Thus, the paper will use SUR to estimate the following two equations jointly:

$$BMI_{Before\ COVID-19} = \beta_{10} + \beta x_{1i} + \varepsilon_1 \quad (2)$$

$$BMI_{During\ COVID-19} = \beta_{20} + \beta x_{2i} + \varepsilon_2 \quad (3)$$

where, β_{10} and β_{20} are the intercept terms before and during COVID-19, βx_{1i} and βx_{2i} are vector of explanatory variables, ε_1 and ε_2 are the error terms.

4. Results and discussion

The results of the T-test, Wilcoxon signed-rank test, and McNemar test (McNemar, 1947) are reported in Table 11.

Table 11: Sample mean differences test and association test

Null hypothesis	Test	P-value	Decision
There is no significant difference in the mean BMI of students before and post-COVID-19 pandemic	Paired t-test Paired Wilcoxon test	7.678e-09 1.783e -09	Reject null hypothesis
There is no association between fruit consumption before and post-COVID-19 pandemic	McNemar test	0.0625	Fail to reject null hypothesis
There is no association between vegetable consumption before and post-COVID-19 pandemic	McNemar test	0.387	Fail to reject null hypothesis

In order to examine if there is a significant difference in the mean BMI of students before and during the COVID-19 pandemic, t-test normality assumptions have to be checked. The results of the Shapiro-Wilk test show that we reject the normality assumption indicating the appropriate test is the paired Wilcoxon test. However, we report t-test for comparison purposes. The results of the paired t-test and Wilcoxon test both agree that there is a significant difference in the BMI of students before COVID-19 and post-COVID-19 pandemic. The results show that the precautionary procedures related to COVID-19, such as quarantine procedures and distance learning, have indeed affected students' BMI.

A study by Teixeira et al. (2021) indicated that social isolation affects the eating habits of children and adolescents. Furthermore, in the United States of America, the number of obese and overweight children aged 18 years and under increased due to the closure of the COVID-19 pandemic (Mulugeta and Hoque, 2021). According to Kriaucioniene et al. (2020), some of the leading causes of weight gain during the COVID-19 pandemic are the increased consumption of sugary drinks and foods rich in fats and carbohydrates and snacks as well as a decrease in physical activity. Also, Elmacıoğlu et al. (2021) showed that social isolation during the quarantine period led to a significant increase in emotional eating, especially when individuals feel bored; they eat more than when they feel depressed, anxious, and stressed.

Furthermore, the McNemar test showed no significant association at the five percent level between fruit consumption before and after the COVID-19 pandemic. However, the test rejects the null hypothesis at the ten percent level, indicating an association between fruit consumption and the COVID-19 pandemic. In addition, the McNemar test shows no association between vegetable consumption before and during the COVID-19 pandemic.

López-Bueno et al. (2020) indicated that the quarantine period reduced physical activity levels and consumption of fruits and vegetables and increased screen exposure and bedtime. On the contrary, as mentioned by Kołota and Głąbska (2021), it was noted that during the distance learning period due to the quarantine of COVID-19, the consumption of fruits and vegetables increased more than before the pandemic. The study showed that the percentage of fruit and vegetable consumption increased during the pandemic compared to the period before that. Fruit

consumption was (27.4% compared to 19.0%) which represents at least three servings of fruit per day. Also, the percentage of vegetable intake was (11.1% versus 7.5%), representing four or more servings of vegetables per day. Also, Wang et al. (2021) indicated a significant increase in the consumption rate of fruits and vegetables during the quarantine period.

Eqs. 2 and 3 were estimated using R software, and the estimated parameters are reported in Table 12. An interaction term was added to account for the fact that as students get older, their weight is expected to increase. Also, the models were estimated with heteroscedasticity robust standard error.

Table 12: Estimated parameters of seemingly unrelated regression method

Variable	Parameter	Variable	Parameter
Before COVID		During COVID	
Intercept	31.146*** (2.489)	Intercept	34.970*** (2.867)
Age	-1.578*** (0.210)	Age	-2.082*** (0.222)
Age*Weight	0.016*** (0.002)	Age*Weight	0.019*** (0.002)
Gender: Male	1.328 (0.812)	Gender: Male	2.079** (0.845)
Fruit consumption	-2.982*** (1.085)	Fruit consumption	-2.329* (1.207)
Vegetable consumption	2.430** (1.035)	Vegetable consumption	3.965*** (1.282)
TV one hour	-0.678 (1.221)	TV One hour	-5.008*** (1.329)
TV 2-3 hours	-0.692 (1.391)	TV 2-3 hours	-2.222 (1.548)
TV more than 3 hours	2.026 (1.537)	TV more than 3 hours	-2.573* (1.414)
Social media one hour	-0.158 (1.459)	Social media one hour	3.156** (1.455)
Social media 2-3 hours	1.875 (1.330)	Social media 2-3 hours	2.723* (1.449)
Social media more than 3 hours	2.430* (1.435)	Social media more than 3 hours	6.617*** (1.484)
Mother's Education: Illiterate	-18.486*** (1.830)	Mother's Education: Illiterate	-16.391*** (2.629)
Mother's education: High school or less	-2.269** (1.056)	Mother's education: High school or less	-1.832 (1.176)
Mother's education: Diploma	-2.026 (1.240)	Mother's education: Diploma	-2.153 (1.669)
Mother's Education: Postgraduate	7.225*** (2.344)	Mother's Education: Postgraduate	3.963*** (1.339)
Father's Education: Illiterate	12.118*** (1.420)	Father's Education: Illiterate	9.121*** (2.166)
Father's education: High school or less	0.872 (1.170)	Father's education: High school or less	-0.347 (1.617)
Father's education: Diploma	-0.384 (1.164)	Father's education: Diploma	-1.629 (1.217)
Father's Education: Postgraduate	-2.201** (1.093)	Father's Education: Postgraduate	-1.416 (1.445)
		COVID infection	-1.483* (0.893)

Note: ***, **, * indicate significance level at 1%, 5%, and %10, respectively

The results in Table 12 show that for every additional increase in students' age, we expect their BMI to decrease by approximately 1.5 units before the COVID-19 pandemic and two units during the COVID-19 pandemic. Also, the average BMI for a male student is greater than female student by two units during the COVID-19 pandemic. Students who consume fruits either before or after the COVID-19 pandemic have, on average, lower BMI scores than those who do not consume fruits by approximately two units. On the other hand, students who consume vegetables before or during COVID-19 have, on average, BMI scores greater than those who do not consume vegetables. Surprisingly, watching TV for at least one hour during the COVID-19 pandemic is associated with a lower BMI score than students who watch TV for less than an hour. This can be attributed to the awareness and educational programs that many TV channels broadcasted during the COVID-19 pandemic. Conversely, students who spend at least one hour on social media platforms have a higher BMI score compared to those who spend less than an hour a day. This fact is attributed to the fact that many social media celebrities in the Arab world are actually marketing food, desserts, and drinks to their followers and encouraging them to purchase and consume more food and desserts. Aldossari and Al-Mahish (2021) showed that social media users prefer unhealthy and poor-nutrient food to healthy and rich-nutrient food.

According to Antonogeorgos et al. (2013), the high educational level of the parents is linked to a healthy lifestyle and good nutritional habits in children; this is evident in the time allocated for practicing sports activities and regularly eating breakfast and other meals during the day. Our results show that if a student's mother is illiterate, the student is expected to have a lower BMI score compared to a student whose mother is a college graduate. Conversely, the BMI score for a student

whose mother is the holder of a postgraduate degree is expected to be higher than a student whose mother is the holder of a bachelor's degree. On the contrary, if a student's father is illiterate, his BMI score is expected to be higher than students whose father holds a bachelor's degree. On the other hand, in Saudi Arabia, children of educated mothers are more likely to be obese because they spend more time away from their children due to study, work, or social activities. This, in turn, makes mothers highly dependent on foreign caregivers or maids to take care of their children (Al Alwan et al., 2013). This exposes their children to unhealthy eating habits such as skipping main meals and relying on snacks (Gaina et al., 2009; Al Alwan et al., 2013).

Finally, students infected with the Coronavirus are expected to have, on average, lower BMI scores compared to those who were not infected by the coronavirus. This may be due to the symptoms associated with the COVID-19 virus infection that affects the digestive system, such as nausea, vomiting, diarrhea, and loss of appetite (Ghoshal et al., 2020). It should be mentioned that a study by Al Meani et al. (2020) indicated that infection with the COVID-19 virus causes an irregular increase in weight among people recovering from infection.

It is clear from the tests carried out that the COVID-19 pandemic affected the body mass index in children and adolescents. Many factors have been linked to these effects. Dietary habits, parents' educational level, as well as the lockdown, in general, were some of the main influences in changing BMI in children and adolescents. Physical activity is one of the most critical factors that were affected by the pandemic and caused an increase in participants' BMI. The lockdown affected decreasing physical activity due to the closure, as education shifted from traditional to distance learning, and entertainment and sports centers were closed.

In the same way, as proven and evidenced by a study by El Zoghbi et al. (2022), the impact of the pandemic on the body mass of physical education students. The study showed that when the sample was studied as a group, the effects did not appear clear compared to the study of individual cases. As indicated, significant differences and increases were noticed in MBI due to the lack of physical activity among the participants.

Recent research by Palermi et al. (2022) reached the same results, showing that the pandemic had a direct impact on the increase in children's BMIs, as the closure greatly affected the physical activity and dietary habits of families in general and children in particular. The study found that a preference for eating fast food, eating snacks, consuming sugary drinks, and spending most of the time sitting without doing any kind of movement are all determinants of weight gain. However, the study believes that the pandemic is not the main reason for the increase in BMI in children, as it found an increase in children's BMIs in general, before and after the pandemic.

On the other hand, despite the results obtained from our study that the COVID-19 pandemic was closely associated with an increase in BMI in children and adolescents, a study by Shalitin et al. (2022) found that there was a decrease in BMIs of overweight children in the age group (2-6 years). The study also showed that increasing BMIs in children existed before the COVID-19 pandemic and continued after the closure and quarantine.

5. Conclusions

Quarantine has been imposed in many countries, which affected many essential areas of life, especially the health of individuals, whether the impact is direct such as infection with the Coronavirus, or indirect such as weight gain. This study aimed to study the effect of the quarantine period and distance learning during the Coronavirus pandemic on school students' body mass index (BMI) in Saudi Arabia. The study sample included 104 respondents representing male and female students from the three school stages (primary, intermediate, and secondary). The questionnaire included questions related to demographic data and anthropometric measurements of male and female school students. The questionnaire also included questions about students' eating habits, physical activity, and inquiries related to social media platforms, watching television, electronic games, the number of meals consumed, and eating fruits and vegetables for the period before and during the pandemic. The data obtained were analyzed through "R" software. Also, several tests were conducted to analyze differences in mean BMI and examine the association among categorical variables before and during the pandemic. The results show a significant difference in the mean BMI of students before and post-COVID-19 pandemic. Furthermore, students infected with COVID-19 have a lower average BMI than students who did not catch the infection. The results also revealed that male students have a higher average BMI during the COVID-19 pandemic than female students. For every additional increase in students' age, their BMI score, on average, is expected to decrease. Students who consume fruits are expected to have a lower average BMI score compared to students who do not consume fruits. Conversely, students who consume vegetables are expected to have, on average, higher BMI compared to students who do not consume vegetables. Moreover, the results indicated that parents' level of education can affect their BMI, and the most significant impact occurs when the parents are illiterate. Social media have a considerable influence on students' average BMI scores. The results showed that students who spend more than three hours a day on social media are expected to have an average BMI score higher by six units compared to students who spend less than an hour a day during the COVID-19 pandemic.

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Compliance with ethical standards

Ethical consideration

Parents of primary school students were allowed to fill out the survey on behalf of their children. The survey has been approved by the Research Ethics Committee at King Faisal University, and it has been given approval # KFU-REC/2021-06-31.

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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